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RELATIONSHIP OF VETERINARY SCIENCE TO ANIMAL BREEDING AND PUBLIC HEALTH—LEGAL PROTECTION OF THE PRACTISE OF VETERINARY SCIENCE[1]

By Dr. JOHN R. MOHLER

CHIEF, BUREAU OF ANIMAL INDUSTRY, U. S. DEPARTMENT OF AGRICULTURE

IN holding this twelfth International Veterinary Congress we have come from distant points on the globe largely because research has no national or regional boundaries. Neither does it recognize professional lines of separation. Modern veterinary service rests on a group of fundamental sciences which give the profession the stability of a scientific Gibraltar.

Procedures used in competent veterinary service and in the administration of live-stock welfare are of established soundness and practicability. This is based on broad experience with millions of animals for many years under wide ranges of conditions.

Indeed, in these times of world-wide economic stress and consequent human bewilderment, these large-scale veterinary and administrative experiences with our animal empires may offer a promising field for study in connection with human relationships. Possible applications of work with animals to human affairs occur especially in selective matings, control of numbers, planes of nutrition, adjustment of labor to quantity of work, identification of individuals and large-scale measures to improve health and reduce mortality.

Accordingly, it is hoped that the deliberations of

[1] Address by the president of the Twelfth International Veterinary Congress, Waldorf-Astoria Hotel, New York, N. Y., August 13 to 18, 1934.

this twelfth International Veterinary Congress may merit the attention not only of scientific workers throughout the world, but also of our statesmen, economists and all thoughtful people seeking to find a key to greater human welfare.

VETERINARY SCIENCE AND ANIMAL BREEDING

The subject on which I have the honor to address you involves three topics, which for many years have received the attention of the veterinary profession. Though seemingly diverse, these branches of activity —animal breeding, public health and legal protection of veterinary practise—are nevertheless closely related. In fact, they have their origin in a common root deeply embedded in the soil of tradition. They symbolize man's efforts to surmount the risks of his existence on this earth.

The practise of animal breeding is centuries old. It had its origin in the economic need of ancient man to produce animal life under some form of organized human control. In the oldest laws in the world, known as "The Laws of Hammurabi," it is indicated that some sort of regulatory system over animal breeding existed in Babylonia 2,100 years before the advent of the Christian era. Any one who regards the chicken industry of to-day as a modern economic development might peruse the laws of the old Assyrian Empire with interest. The numbers of eggs laid by each hen were counted and recorded.

In that early and now dim date in man's history many of the diseases of animals and poultry were identifiable by names peculiar to the times. The contagious nature of animal plagues is clearly indicated by Columella, who lived at the dawn of the present civilization. That he recognized a relationship between animal breeding and public health is evident from his urgent demand for segregation of the sick as one means of preventing the spread of infection. The Christian era was still very young when Vegetius, aroused by the heavy losses among animals as each successive epizootic broke over the world, utilized his now immortal pen for the salvation of animal life if only on economic grounds, to save the state from loss, through a revival of interest in what then was known as veterinary art.

In those days of scientific darkness, animal-disease prevention and control were largely in superstitious practises. But the few intellectual freedmen of the age, and those in gathering numbers in each succeeding epoch, realized the need of a true veterinary practise and control over animals and animal production, as related to public health and public welfare generally. As far back as B.C. 40, in the time of Tiberius, Celsus foresaw that methods employed in veterinary clinical work would find a place in the practise of human medicine which two hundred years later Galen emphasized.

Since then, and particularly since the time of Pasteur, veterinary science has been marked by a succession of discoveries which have had the effect of greatly reducing the hazards of animal life and production. Diligent scientific workers, the world over, have traced scores of live-stock maladies to their source, revealing specific viruses, bacteria and parasites as the causes. Other investigators have cleared up many questions concerning nutritional disturbances, poisoning by plants, breeding troubles, even conditions resulting from abnormal glands and disturbances of the nervous system.

Literature on these various contributions of veterinary science is voluminous and familiar to members of this body and their colleagues. Hence, instead of dwelling on past achievements, perhaps our time may be better spent in considering some less often discussed phases of veterinary activities.

In commercial gatherings, for instance, the question of the distribution of goods engages the paramount interest of trade bodies, international as well as national and local. Ours is a scientific and professional assembly, but we also have a problem of distribution, namely, the distribution of veterinary knowledge more generally and more effectively.

Scientists from various countries frequently visit the laboratories of our Bureau of Animal Industry, sometimes remaining several months. They quickly become familiar with our equipment and methods; in fact, they frequently are more at home in our laboratories than in our cities and rural districts. But judging from discussions with these workers and also from data obtained in a recent world survey on live-stock improvement, there is a wide difference among countries in methods by which veterinary science is brought to bear on animal production.

An account of our experience with this question in the United States may be of interest and provide a basis for a helpful interchange of views.

In this country we have about 10,000 practising veterinarians. Approximately 5,000,000 live-stock owners engage in commercial production. The population of cattle, swine, sheep, goats and equine stock is about 200,000,000. A comparison of these figures reveals a ratio of 1 veterinarian to 500 live-stock owners; and a ratio of 1 veterinarian to 20,000 animals.

Thus, it becomes clear that the influence of the individual veterinarian must be extended greatly if his knowledge is to have an extensive application to the business of animal breeding and production.

In dealing with this condition the Bureau of Animal Industry long ago recognized the need for a

definite and consistent policy. Without an established procedure the application of veterinary science to animal breeding would be influenced excessively by personal opinion of various officials. Uniformity in different parts of the country would be lacking. Irregular demands for veterinary service would be created, with consequent disturbing effects on veterinary education.

System of Regulation and Information

The governmental policy of the United States, therefore, consists of both regulatory and informational services.

The regulatory feature includes essentially international and interstate inspection, together with the operation of necessary quarantine stations and disinfecting and dipping facilities. It provides for the immunization of swine which leave public markets for rural points where they are to be used for breeding purposes or further fattening and finishing. It includes supervision over vessel fittings, in connection with the export of live stock, and suitable facilities for feed, water and rest for live stock shipped long distance by railroad.

In this regulatory work is an extensive meat-inspection service, which shall be considered more in detail in another place.

Furthermore, the Bureau of Animal Industry cooperates with states in the eradication of animal diseases, particularly those of dangerous character. Such work is conducted under the laws of the various states, by cooperative agreements between the government and the state. Although these activities are carried out by federal and state veterinary inspectors, the Bureau of Animal Industry maintains lists of private veterinary practitioners who are qualified for such duties.

All these official duties are systematically and continuously conducted. In general, they have been highly effective in accomplishing the results for which they are intended. An effective barrier has been raised against the spread of animal disease from one part of the country to another. The health of live stock in transit has been safeguarded. The eradication or control of many serious maladies has been accomplished.

But, far-reaching as are these regulatory measures and procedures, the Bureau of Animal Industry recognizes the need for the widest extension of its services to the millions of farmers, ranchers and other owners of the nation's live stock. And so, where official regulatory work leaves off, a planned system of information begins, carrying knowledge of disease prevention and control to owners, veterinarians, public officials and all others interested in live-stock welfare.

Many tested methods of distribution are utilized for this informational service. These include the press, agricultural extension agencies, publications, motion pictures, exhibits, other pictorial matter and radio broadcasting. As an example of the scope of this informational work, the Bureau of Animal Industry has prepared 67 publications that deal with animal diseases. Of these, all told, about a million copies a year are circulated throughout the country. Appreciating the value of educational motion pictures in improving stock raising, we have prepared 50 motion pictures of which 13 deal with disease control and live-stock health. Last year showings of these pictures were made on about 300 occasions before audiences aggregating about 80,000 people.

Cooperation with and by Practising Veterinarians

The distributed information is of a character that live-stock people can use to specific advantage, and our experience indicates its constructive value. It familiarizes owners and others with the importance of disease and parasite control. It overcomes misinformation, prejudice and superstition. It emphasizes the value and need of qualified veterinary service, as contrasted with ineffective, wasteful and often cruel methods.

For instance, in its educational work on hog-cholera control, the Bureau of Animal Industry acquaints swine growers with the value of the preventive-serum treatment, and the sanitary precautions that help to keep swine herds free of cholera, but it also points out the importance and desirability of having a qualified veterinarian apply the preventive-serum treatment when needed.

Another example where the educational work of the bureau should not involve recommendations or activities that would tend to conflict with the work of veterinary practitioners is in the control of horse bots, a parasite that is the cause of serious injury in some parts of the country. The educational work is organized largely by extension workers who arrange for the treating of all horses in a community. They explain the methods, benefits and cost, but the actual treatment is given by veterinarians who cooperate in the enterprise. In the case of Bang's disease, or infectious abortion, the informational service involves particularly publications and the radio broadcasting of latest results of experimental work, with suggestions that specific procedure should preferably be under veterinary supervision.

Stockmen Warned Against Ineffective Drugs

Supplementing the informational services of the Bureau of Animal Industry, the Federal Food and

Drug Administration—also a branch of the U. S. Department of Agriculture—has performed a further service. It has called public attention to a waste of millions of dollars annually spent for drugs and nostrums that are worthless in the prevention or treatment of live-stock diseases.

As a result of a five-year survey, it has been shown that though most manufacturers put out honest goods and advertise them truthfully, others make exaggerated claims unsupported by the merits of the goods so advertised.

As a result of such claims farmers have been led to believe that medicines are available that will prevent or cure such diseases as hog cholera, infectious abortion of cattle and blackhead of turkeys; that the medicines will keep their stock healthy and producing, and increase the milk yield of cattle and the egg yield of fowls. These claims lead worried farmers to believe that these so-called remedies will do things which medicines simply will not do.

Though there is lack of reliable figures on the money spent annually for proprietary remedies, several estimates indicate that it considerably exceeds ten million dollars. It is not unusual for dairymen whose incomes are very meager to spend as much as $10 a pound for worthless abortion remedies. The survey of the Federal Food and Drug Administration embraced the entire field of veterinary preparations. It included a study of more than 1,000 misbranded or worthless antiseptics, stock powders, tonics, liniments, salves, and the like. Through its informational efforts, which urge farmers, before purchasing medicines, to consult a veterinarian as to the possible effect, much of this enormous waste can be checked.

Better knowledge among stock owners concerning animal diseases should lead to a higher plane of live-stock health and increased appreciation of capable veterinary services.

Quality of Live Stock of Veterinary Interest

Any consideration of the relationship of veterinary science to animal breeding inevitably leads to the question of quality of animals as well as their numbers, for the very significant reason that owners of improved live stock not only are interested in animal-disease prevention and control, but have animals that justify veterinary services to keep them well and productive.

For more than a decade, the Bureau of Animal Industry has conducted a systematic campaign to encourage live-stock improvement. This interest involves, in particular, the production of purebred stock and the establishing of studs and herds of high breeding and utility value. Records of this activity have shown that the ownership of a few purebred animals quickly leads to the acquisition of more improved stock and to general interest in higher types of domestic animals.

In conducting this campaign, we distribute extensive printed information on animal breeding and feeding. Gratifying reports from persons who have adopted our recommendations indicate that their improved stock has a utility value fully one third greater than that of unimproved farm animals. We have also observed that when stockmen request literature on production subjects, they seek also the latest facts concerning practically all animal maladies. This is a line of work that, as a veterinarian, I have been proud to sponsor and aid.

Here mention should be made of the contact between veterinarians and poultrymen in the United States, especially in the control and eradication of tuberculosis and pullorum disease. They are in frequent consultation on the best scientific and practical means of reducing mortality in breeding and utility poultry flocks. This interest has arisen (1) through an increased attention to poultry health, (2) as a result of extensive interstate shipments, especially of baby chicks, and (3) from efforts toward general flock improvement involving the production of birds having high intrinsic value.

Thus, veterinary science and animal and poultry husbandry intertwine at many points, from breeding and health activity on farms and ranches to the inspection of exhibition animals and fowls intended for fairs and expositions. Veterinary science aids in attaining a high development of breeding. In reciprocating measure, advancement in breeding is distinctly beneficial to the veterinary profession.

Here enters public health.

Veterinary Science and Public Health

Man's interest in public health is the cooperative expression of study and effort to reduce the risks of his existence on this earth by endeavoring to surmount the threat of disease. In this is involved the fundamental subject of nutrition.

Live stock are remarkable mechanisms for converting the earth's vegetative growth into food that has become indispensable for man's needs. Meat, milk and eggs have been a part of the human diet since primitive times. With the development of complex systems of distribution, our modern civilization has required, for its protection and welfare, systems of meat and milk inspection together with supervision over other foods.

In the United States our federal meat inspection, already mentioned, involves the veterinary examination of approximately 70,000,000 food animals a year. The regulations under which meats are either passed for food or are condemned rest on established princi-

ples of veterinary science and hygiene. This service, administered by the Bureau of Animal Industry, has been in operation so many years that our citizens now accept it as a public utility.

Federal meat inspection not only is a barrier to the possible spread of infections of animals to human beings, but it provides other public health safeguards. It includes supervision of ingredients used in the curing of meats. It insures proper sanitation. In general, it surrounds the inspected meat food supply with conditions that appeal to man's sense of refinement.

Meat Inspection Aid Saves Human Lives

In the administration of the meat-inspection act consideration is given to requests from reputable physicians, medical institutions and pharmaceutical manufacturers for products thought likely to be of value in human medicine. An incident that occurred in one of our central states gives a human touch to this form of cooperation. A young man 22 years old was suffering from aplastic anemia. The disease was sapping his vitality. In their extremity, hospital officials finally appealed to the federal meat-inspection service. They desired foetal calf liver as a last resort in the hope of saving their patient. Arrangements were quickly made to obtain the liver of the unborn calf under veterinary supervision. When administered, it stopped the bleeding common to this form of anemia. Nothing else had seemed to have any effect.

This combined medical and veterinary procedure has had a happy ending in the complete recovery of not only this young man, but numerous other patients afflicted with the same disease, whose previous condition had been desperate.

The veterinary supervision of animals at time of slaughter is also the basis for an extensive pharmaceutical industry, as my colleagues who are engaged in the administration of meat-inspection activities are well aware. Mankind has come to depend on the glands and other parts of animal bodies for scores of preparations used in the treatment of human ailments.

Similarly, manufacturers of antitoxins, serums, bacterins and other biological products utilize methods many of which have their origin in veterinary science; in fact, numerous establishments licensed by the Bureau of Animal Industry for the production of biologics produce these articles for both medical and veterinary use.

Veterinary Service Protects Milk Supplies

In the case of milk supplies, sanitary control of this fluid has been vested largely in medical officers. They, in turn, through a broad conception of the problem, have seen the need of veterinary inspection as well. The veterinarian applies the tuberculin test, observes dairy herds for other possible infections and performs related services coming within his qualifications. The medical profession commonly centers its attention on the purity of fluid milk and cream and their products, with respect to compliance with established grades and standards.

This joint supervision has brought remarkable improvements in the wholesomeness of milk supplies with well-recognized benefits to public health through reduction of tuberculosis, typhoid fever, septic sore throat and other maladies.

The relationships between medical and veterinary science are especially illustrated in the field of anthelmintics for parasitism of man and his animals where they are so close that they merge into a common interest. Of specific maladies that intrude on the health of both the human and the lower animals, the more familiar include anthrax, rabies, tuberculosis, milk sickness and parasitic infestations. In addition, there are others of less common occurrence and also several so-called border-line infections in which the form of human disease closely resembles that of a corresponding animal malady, though the exact relationship may not yet be fully understood. Obviously, there is broad medical and veterinary interest in this conjoint field of science.

Because of this close relationship of the two sciences, eminent medical authorities frequently appear on the programs of our veterinary organizations, and officials engaged in live-stock-sanitation work consult with equal freedom the leaders of thought in human medicine.

Veterinary Versatility

Through wise leadership, scientific institutions and organizations representing both fields of science have performed valuable services in making special studies that indicate trends in veterinary and public health work.

A few years ago the College of Veterinary Medicine of the Ohio State University sought to adjust its course of study in order to prepare its graduates better for duties they were likely to be called upon to perform. A questionnaire was sent to the health departments of a large number of municipalities. The results when analyzed disclosed that many departments of health included veterinary divisions engaged in milk and meat inspection, also that fully 75 per cent. of the veterinarians engaged in such work conducted general food inspection. Their duties frequently extended to the inspection of the food-storage departments and kitchens of hotels, restaurants, confectioneries and other establishments engaged in preparing and dispensing human food.

Somewhat the same situation has developed in the

federal service. In connection with the inspection of meat for other branches of the government, including hospitals and institutions, veterinarians of the Bureau of Animal Industry often make supplementary examinations of various food products not of animal origin. Thus fruits, vegetables and bakery products frequently receive official inspection at the hands of veterinarians; and the procedure has proved to be satisfactory. This type of service is incidental, of course, but it illustrates the infiltration of veterinary service into public health activities and into the supervision of the public's food supply.

Possible Key to Greater Human Welfare

The versatile character of veterinary work in connection with human affairs offers many arresting reflections. We have seen how veterinary science safeguards human food. In the realm of power and labor, veterinary science contributes materially to the supply and efficiency of work stock for farms and industry, likewise to the development of equines for sport and recreation. What has been done in behalf of food, health, agriculture, industry and pleasure has also been extended to help solve other types of problems. For instance, our research on tick fever opened a new field in medical science as it was first to prove that insects carry disease. This discovery was the basis for controlling malaria, yellow fever, typhus fever, bubonic plague and many other human diseases carried by insects. At the fiftieth anniversary of the American Veterinary Medical Association, held in this city 21 years ago, I pointed out that but for this pioneer work the Panama Canal would not have been built so expeditiously.

Another new medical principle was established by the Bureau in proving that the injection of sterilized cultures or dead bacteria of a disease may confer immunity to subsequent infection with virulent organisms of that malady. This discovery was also fundamental and led to the brilliant results since obtained in controlling typhoid fever and other human diseases by bacterin therapy.

One of the most outstanding discoveries in the field of veterinary science during the last two decades was made in our Bureau laboratories. Quite surprisingly this discovery definitely disclosed the intimate relationship of the causal agent of infectious abortion of cattle to that of undulant fever of man. Subsequently this phase of the work and the scientist who initiated it were transferred to the U. S. Public Health Service.

Such contributions of veterinary science to medicine suggest the possible value of still other applications helpful to man. Just as the rabbit and guinea pig serve individually as humble test animals in medicine, so also eventually human society may discover enlightening aids for the adjustments and regulations of its own economy in the scientific and regulatory procedures pursued by the veterinary profession in administering the singularly comparable affairs of our vast animal empires.

(To be concluded)

SCIENTIFIC EVENTS

REPORT OF THE BRITISH EMPIRE CANCER CAMPAIGN

At the annual meeting of the British Empire Cancer Campaign the report, which was presented and approved, stated, according to the *Journal* of the American Medical Association, that the main attack in the battle against cancer was now being directed against the cancer cell itself. Knowledge was increasing about the cell and about the chemical reactions that occur within it in the body. Such knowledge justified a sober optimism, for the enigma of the cancer cell might be looked on as the last defense of the disease. Mr. Cecil Rowntree, surgeon to the Cancer Hospital, said that the report showed that the purposes for which the campaign were founded were being fulfilled in all directions. One purpose was the coordination of research and research organizations not only within Great Britain but throughout the empire. The recent steps of setting up a panel of international correspondents, whereby they had an accredited representative in each of the great scientific capitals, added to the accuracy and promptness of their foreign information. The investigations carried out at the Cancer Hospital and at the Middlesex Hospital suggested the possibility that the ultimate cause of cancer might be something of a chemical nature produced by disordered functions within the body itself. An admirable attempt to develop a new line of attack on cancer of the esophagus by intensive roentgen therapy had been made at St. Bartholomew's Hospital. In his Garton prize essay Dr. Colwell described the action of radiations on normal and malignant cells. All these provided encouraging indications of new and profitable avenues of research. In the direction of prevention they could point to great increase of knowledge of the nature of precancerous conditions, and in particular to the likelihood of a great diminution of the incidence of industrial cancer as the result of investigations into the carcinogenic agents in lubricating oils and other industrial materials.

On the curative side they could point to recent ad-

vances in radiation treatment. Partly in consequence of the campaign a silent revolution had been effected, for it seemed that the recent changes witnessed in the radium practice of the whole cancer world were no mere therapeutic experiments of passing interest but evidence of fundamental change in the picture of cancer treatment. The radium bomb, so called, was coming to be regarded as a necessity of all well-equipped cancer centers. Fortunately the radium position had been materially eased by the discovery of radium deposits in Canada. It was not pretended that radium was a cure for cancer in the ordinary acceptance of the term, but in certain cases it gave results not hitherto obtained by any other method. One had only to point to cancer of the lip, tongue and uterus to realize the change in current practice. In these situations radium had in part or in whole replaced operative surgery. There was no hope that some sudden flash of genius would solve the cancer problem in a day. Every indication seemed to point to the necessity for laboratories and concentrated effort by skilled teams of workers, who, by pooling their experience and repeating and correcting one another's observations, would ultimately arrive at the truth.

THE BARUCH RESEARCH LABORATORY AT SARATOGA

THE cornerstone of the new Baruch Research Laboratory, named in honor of the late Simon Baruch, to be built at a cost of $750,000 at the Saratoga Spa, New York, was laid by Dr. Herman B. Baruch, taking the place of his brother, Dr. Bernard M. Baruch, who was abroad. Earlier this year Dr. Baruch established the Simon Baruch Medical Research Foundation, in memory of his father. Governor Herbert H. Lehman presided over the ceremonies and Dr. John Wyckoff, dean of New York University-Bellevue Medical College, made the principal address.

Five other buildings are under construction at the Saratoga Spa—the Hall of Springs, whose cornerstone was laid in July of last year; a bath house, a hotel with sanitarium facilities, a recreation center at which scientific recognition will be given to the therapeutic values of sports, and a bottling plant which will make possible a distribution of Geyser, Hathorn and Coesa waters three times as great as that now carried on by the state.

Construction contracts for these six buildings reach a total amount of $2,786,638. Furnishings and equipment will cost approximately $1,000,000 more, while landscaping and the golf course that will adjoin the recreation center will bring the cost to $4,000,000. The Hall of Springs, the research laboratory and the recreation center are all far advanced; foundations and steel work, with much of the inclosures, of the others will be completed before winter sets in.

Four years ago $2,000,000 was appropriated by the New York State Legislature for the carrying out of the first steps of the program submitted by the special commission of which Bernard M. Baruch was chairman, a program that was adopted and made a permanent part of the public health policy of the state. This appropriation provided the $900,000 that is being spent on the Hall of Springs and $400,000 for the first unit of the research laboratory.

A Reconstruction Finance Corporation loan of $3,200,000 became available last October. It is a stipulation of the contract that the project shall be completed by the fall of 1935.

In design and equipment the research laboratory is the joint product of Dr. Franz M. Groedel, director of the Kerckhoff Institute for the Study of Affections of the Heart, Bad Nauheim, Germany, consultant of the Saratoga Springs Commission; Walter S. McClellan, medical director; Cyrus Bruce Elmore, superintendent of the plant, and Joseph H. Freedlander, who also was architect of the Hall of Springs.

THE THREE HUNDREDTH ANNIVERSARY OF THE ESTABLISHMENT OF THE CHEMICAL INDUSTRIES

THE three hundredth anniversary of the establishment of the chemical industries in America will be celebrated at a meeting to be held in New York City by the American Chemical Society during the week beginning April 22, 1935.

According to an announcement made by Professor Arthur W. Hixson, of Columbia University, who has been appointed general chairman of a New York Committee of Arrangements, from 7,000 to 10,000 representatives of chemical science, the chemical industry and allied fields will participate. It is hoped that President Roosevelt will consent to deliver the opening address.

Professor Hixson writes:

> Leaders in industry, finance and government will unite with the chemists in centering world attention upon the nation's growing chemical industries, whose magnitude can now be computed only in "figures of astronomical proportions."
>
> With tremendous resources available in the form of nearly a half million known and unused chemical compounds, and with its highly trained and experienced technical personnel and flexible plant equipment, the chemical industry can be depended upon to lead the nation out of the depression. A survey, just completed, shows that research work has been continued without abatement by the chemical industries during the depression. Many new processes have been developed for making products that could not formerly be produced economically and many new products have been developed that have been designed to meet the needs of new and better living conditions. As soon as confidence in the

business policy of the nation is established, many new plants will be built and a flood of new products will come on the market. Modern American chemical industry is built solidly upon research and stands ready to bring new industrial life to the nation.

A study of world production of chemical products strikingly indicates the leading position of the American chemical industries. The annual production of chemical products in which these industries lead the world, such as petroleum products, rubber, cement, heavy chemicals, metal products, agricultural chemicals, engineering chemicals, explosives, foods, processing chemicals, air chemicals, sea water and brine chemicals, paints, pigments and many others are recorded in figures of almost astronomical proportions and whose values run into billions of dollars.

To-day, the United States produces more than three times as much sulphuric acid as Germany, four times as much as Great Britain, five times as much as France or Japan, and more than one third of the world output. Another typical product is chlorine. The United States produces more of this product than all of the rest of the world combined. Charleston, West Virginia, alone has a greater annual chlorine production than Germany. There are several alkali plants each of whose monthly production is greater than the annual output of Italy. The same supremacy is held by petroleum products, metal products, cement, synthetic textiles, rubber products, artificial leather and many others.

There will be held at the New York meeting a symposium on "The Economic, Social, Scientific and Political Structure of the Chemical Industries" by leading industrialists, financiers and scientific men. The program is being arranged with the assistance of the Merchants' Association, educational, art and other institutions.

THE SCIENCE EXHIBITION AT THE PITTSBURGH MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE Annual Science Exhibition of the American Association for the Advancement of Science will be held in the new building of Mellon Institute of Industrial Research during the association's meeting in Pittsburgh, December 27, 1934, to January 4, 1935. The exhibits, which will feature science in industry, particularly about Pittsburgh, will be on the third, the street level, floor of the institute's new home, just off Bellefield Avenue. At recent American Association for the Advancement of Science meetings there has been a growing recognition of the importance of the exhibition, and it is thought that the exhibits at Pittsburgh will be the most extensive and instructive ever shown.

The Committee on Exhibits, directed by Dr. F. C. Brown, and the local exhibition committee under the chairmanship of Dr. L. O. Grondahl announced on September 15 that about two thirds of the available space had been taken. As there will be about 4,000 in attendance from all parts of the United States and Canada, besides a somewhat larger number of manufacturers, scientists and teachers from the Pittsburgh area, it is recognized that exhibitors will have unparalleled opportunities to make contacts, to extend good will and to maintain prominence before a class of visitors whose opinions are weighty.

There will be many special attractions at the exhibition. In addition to the numerous commercial exhibits, there will be displays of cosmic ray research, deuterium, neutrons and induced radioactivity. There will also be presentations of equipment used in stratosphere flights, demonstrations of talking films with new subjects in the physical sciences, large biological displays and illustrated showings of recent advances in other sciences, particularly physics.

As mentioned, Mellon Institute will be the host to this exhibition. Every one who attends will therefore be able to see the principal features of the institute's beautiful new temple of science. Specialists interested in laboratory construction, equipment and operation can secure permission to inspect the facilities of the new building and can also see the displays of many companies that have made developments through the institute. There will be a reception room and lounge where members of the association may meet and confer or rest. Each afternoon tea will be served in the lounge, which will be made comfortable and attractive by aluminum furniture.

The exterior of the new building of Mellon Institute is completed and continuous progress is being made in the interior. Special attention is being accorded to finishing the laboratory rooms on the fifth and sixth floors. The erection of this edifice was commenced in 1930, and the structure is so designed that it will furnish the institute with the means for expanding greatly its research facilities and activities in both pure and applied science. The present two buildings of the institution are inadequate for the future needs of its departments and industrial fellowships, and hence the commodious modern home now under construction will be occupied just as soon as it is completed, during the fall of 1935. The building is of that type of classical Greek architecture known as Ionic; it is plain but massive, and is surrounded by 62 monolithic columns. Indiana limestone and granite are used throughout the exterior. The proportions of the building are about 300 x 275 feet, and there are nine floors. The main entrance, which is on the fourth floor, is reached by steps extending along the entire front on Fifth Avenue. The laboratories face on interior courts.

The architectural design of the exterior was perfected in detail by methods that involved the construc-

tion of three different models and numerous alterations and artistic refinements at each of these stages. The architects, Janssen and Cocken, first had made a model of the entire building to a scale of 5/32 in. to 1 ft. Then, after study and many changes in details, a larger model of a portion of the building was constructed to a scale of ¾ in. to 1 ft. Finally, it was decided to erect in the country near Pittsburgh a full-size model in stucco of a corner and two columns of the building; this model, about 90 ft. high and 40 ft. long, enabled the architects to determine the particulars of the most appropriate adornment of the building. A number of improvements in form and ornament of the columns and entablature were in fact accomplished in this manner. Similar caution and certainty, through experimental study and practical trial, are guiding H. S. Coleman, the institute's engineer, and the architects in solving problems encountered in the construction of the interior of the building and especially of the laboratory rooms. To facilitate dependable results in this planning, the institute erected a temporary, one-story structure, 45 ft. x 50 ft., in which two different sized laboratories, completely equipped, were built, and in which aluminum sash, various wall and flooring materials and different types of radiators have been installed and put to test. This "proving house," which has been making it comparatively easy to get early answers to constructional questions of importance, including problems of plumbing, electrical layout and lighting arrangements, will be open during the Pittsburgh meeting.

W. A. HAMOR

SCIENTIFIC NOTES AND NEWS

THE autumn meeting of the National Academy of Sciences will be held at Cleveland under the presidency of Dr. W. W. Campbell on November, 19, 20 and 21.

THE fifteenth International Physiological Congress will take place at Leningrad and Moscow from August 9 to 17, 1935. Professor Ivan P. Pavlov, who celebrated his eighty-fifth birthday on September 14, has been elected president of the congress. Board and lodging will be provided for members and arrangements will be made for visits to several parts of the country at reduced rates.

AT the Aberdeen meeting of the British Association for the Advancement of Science, it was agreed that the meeting at Norwich next year, under the presidency of Dr. W. W. Watts, should be held from September 4 to 11. Invitations have been accepted from Blackpool for 1936 and from Nottingham for 1937. An invitation from Cambridge City and University to hold the meeting of 1938 in Cambridge was accepted. A deputation was received from the City of Dundee and the University of St. Andrews, with its branch in Dundee, to hold the meeting of the association in Dundee in 1939 or 1940, the alternative having been given in view of a possible visit of the association to one of the Dominions in one of these years.

COLONEL SIR CHARLES CLOSE, vice-president of the Royal Geographical Society, was elected president at the fourteenth meeting of the International Geographical Union, held in Warsaw from August 23 to 31. He succeeds Dr. Isaiah Bowman, chairman of the National Research Council and director of the American Geographical Association. There were 887 delegates representing 44 countries at the meeting. France had 102 delegates, the British Empire 58 and Germany 50. The fifteenth congress will be held at Amsterdam in 1938. Sir Charles, who retired from the army in 1922, was president of the British Geographical Association in 1927 and president of the Royal Geographical Society from 1927 to 1930.

AT the fifty-second meeting of the American Astronomical Society held at Connecticut College from September 10 to 12, the following officers and members of the council were elected: *President,* H. N. Russell; *Vice-president,* C. A. Chant; *Secretary,* R. S. Dugan; *Treasurer,* F. C. Jordan; *Councilors,* Cecilia Payne Gaposchkin, W. E. Harper, J. H. Moore and R. E. Wilson. H. R. Morgan was elected a representative of the society on the Division of Physical Sciences of the National Research Council.

DR. FRANK E. BURCH, of St. Paul, Minn., was chosen president-elect of the American Academy of Ophthalmology and Otolaryngology at the annual conference held in Chicago from September 10 to 14, and Dr. Wells P. Eagleton, of Newark, N. J., became president. The medal of honor was awarded to Dr. Carl Koller, of New York, who first introduced cocaine as a local anesthetic fifty years ago.

DR. WALTER L. BIERRING, of Des Moines, Iowa, president of the American Medical Association, was the guest of honor at a dinner on September 4, sponsored by the Los Angeles County Medical Association.

THE University Award granted by Rutgers University for distinguished services was presented on September 18 to Albert E. Meder, associate professor of mathematics at the New Jersey College for Women.

DR. EUGEN FISCHER, professor of anthropology at Berlin, has been awarded the Rudolf-Virchow plaque.

DR. WALTER AND DR. IDA NODDACK, Berlin, have been awarded the Scheele Medal of the Swedish Chemical Society.

THE Paul Ehrlich gold medal was awarded to Dr. Walter Kikuth at a medical meeting held at Frankfurt a/M, from September 2 to 9, under the presidency of Professor W. Kolle. Dr. Kikuth is head of the chemotherapeutic department of the I. G. Farbenindustrie at Elberfeld, where he succeeded the late Dr. Roehl.

PROFESSOR GEORG GAMOW, head of the department of physics and mathematics at the Polytechnic Institute at Leningrad, has been appointed visiting professor at the George Washington University for the coming year. During the summer Dr. Gamow was a foreign visiting member at the twelfth annual physics symposium of the summer session of the University of Michigan. At George Washington University he will give a seminar in theoretical physics and will continue his research on the atomic nucleus.

DR. FREDERICK CLARK HOLDEN, who has been associated with University and Bellevue Hospital Medical College since 1919, has retired as professor of obstetrics and gynecology and has been appointed professor emeritus.

CHARLES J. FISH, director of the Buffalo Museum of Science, has joined the department of zoology at the Rhode Island State College, Kingston.

UNDER the direction of Vladimir P. de Smitt, hydrographer of the Western Union Telegraph Company, who charts the course of ocean cables, an extension course on weather forecasting will be given this year at Columbia University.

DR. HUGH P. BAKER, president of the Massachusetts State College, has been appointed a member of the advisory committee of the New England Regional Planning Commission. The commission, of which Victor M. Cutter is chairman, is a division of the National Resources Board. Dr. Baker, who was formerly dean of the N. Y. State College of Forestry at Syracuse University, has previously served in an advisory capacity to the Westchester Park Commission and other planning activities. He will make accessible to the committee material available in various college departments.

DR. F. S. BRACKETT has tendered his resignation from the Smithsonian Institution in order to devote more time to the investigation of physical problems in connection with agriculture.

DR. JOSEPH S. AMES, president of the Johns Hopkins University, who has been traveling for five weeks in England and Germany, arrived in New York on September 19.

DR. HANS JENNY, associate professor of soils at the University of Missouri, has a year's leave of absence which he plans to spend in work with Dr. W. P. Kelley, agricultural chemist at the Citrus Experiment Station of the University of California.

AT the annual meeting of the Northern Minnesota Medical Association at Brainerd, under the presidency of Dr. A. C. Baker, of Fergus Falls, the evening address on September 10 was an illustrated lecture entitled "Minnesota Man," by Dr. Albert Ernest Jenks, professor of anthropology at the University of Minnesota.

THE Lowell Institute, Boston, has announced eight courses of lectures during the present season. These include a course of seven illustrated lectures by Dr. Cecil K. Drinker, professor of physiology and assistant dean of the Harvard School of Public Health, on "Health, Medicine and Doctors in Colonial Days, as Depicted in the Diary of Elizabeth Drinker, 1758-1807." Dr. Drinker's lectures will be given on Tuesdays and Thursdays, at eight o'clock, beginning on October 16. A course of eight illustrated lectures will be given by Dr. James Bernard Macelwane, professor of geophysics and director of the department of geophysics at Saint Louis University, on "Some Old Seismological Problems and Recent Solutions." These lectures have been announced for Fridays and Tuesdays, at eight o'clock in the evening, beginning on February 1 and omitting February 22.

IN order that methods of carrying on research with pastures and pasture crops might be standardized and results more accurately measured, the American Dairy Science Association last year appointed a committee consisting of I. R. Jones, Oregon; G. Bohstedt, Wisconsin; C. B. Bender, New Jersey; R. B. Becker, Florida, and R. H. Lush, Louisiana, *chairman*. The committee presented a report of progress at the recent meeting of the American Dairy Science Association held in Ithaca, N. Y., from June 25 to 28. Copies of this report are available from the office of Professor Lush, who has been authorized to cooperate with the chairman of similar committees previously appointed by the American Society of Agronomy and the American Society of Animal Production to compile a joint report on "Methods of Pasture Investigations." A final report will be made some time next year.

THE plenary Congress of the International Scientific Radio Union opened in the rooms of the Royal Society, London, on September 11. The union is one of a group of bodies organized in connection with an international council for the furtherance of international cooperation in scientific research. Previous meetings have been held in Washington, Brussels and

Copenhagen. The work of the union is divided into five commissions dealing, respectively, with radio standards, propagation of waves, atmospherics, liaison with amateurs, etc., and radio-physics. The delegates were entertained by the government at a dinner at Grosvenor House on September 18, at which Sir Kingsley Wood, postmaster-general, presided. Further arrangements included a visit to the Rugby and Baldock wireless stations, the radio department of the National Physical Laboratory and the Broadcasting House. On September 17 the delegates attended a reception at the Royal Institution, at which Sir William Bragg gave a short address on the work of Michael Faraday, illustrated by some of the original apparatus used by Faraday.

ACCORDING to *Nature,* an article by Professor P. A. Molchanov in the *Moscow News* reports that the recent All-Union Conference for the Study of the Stratosphere decided to call an international conference, with the same objects to meet in the U.S.S.R. in 1936, the date to be fixed in relation to the total solar eclipse. The Soviet conference of last spring was mainly devoted to a review of the present state of knowledge of the problems of the extra-tropospheric regions of the atmosphere, with some references to their relation to the meteorological processes of the troposphere. The conference passed resolutions dealing with the world conference and with the special need of cooperation among Soviet, American and Canadian scientific workers in polar atmospheric researches.

AN International Museums Conference at Madrid will be held from October 14 to 20. Headquarters will be at the Academy of Fine Arts. A session will be held at Barcelona on October 21.

THE prospectus of courses, lectures and other educational advantages offered to members of the Brooklyn Botanic Garden and to the general public for the educational year 1934–35 has just appeared as the October issue of the Brooklyn Botanic Garden *Record.* Twenty-one courses are offered for adults. Of these courses nine are especially for teachers and have been accepted by the Brooklyn Teachers Association and the New York Board of Education for credit toward higher teaching licenses. In addition, the course for student nurses which has been given for a number of years in cooperation with the training schools for nurses of a number of Brooklyn hospitals is offered again this year. Nine different courses are offered primarily, for boys and girls between the ages of eight and eighteen. The "Prospectus" also includes announcement of opportunities for research under direction and for independent investigation. In this connection the Botanic Garden is in official cooperation with New York University and Long Island University. General statements are given concerning the other educational activities and features of the Botanic Garden, including press releases, broadcasting, popular and technical publications and guide books.

BY the will of the late Nathaniel Lord Britton half of his residual estate is left to the New York Botanical Garden, the Torrey Botanical Club, the Staten Island Institute of Arts and Sciences, Columbia University and the New York Academy of Sciences.

THE new wing of the Sir John Cass Technical Institute, London, will be opened by the Earl of Athlone, chancellor of the University of London, on October 10. The extension of the institute building was made possible when the governing body acquired from the corporation of London the long lease of 2,000 years of adjoining properties. The new site measures approximately 5,000 square feet, and has allowed the frontage of the institute to be extended by about 75 feet. The new wing, designed by Mr. Verner O. Rees, comprises a large hall (with stage), a refectory and kitchen, a staff common room, three large art-rooms and additional laboratories and lecture-rooms for metallurgy, physics, organic and biochemistry. The increased floor space has enabled the governors to rearrange the interior of the original building and to provide a library and reading room, a students' common room, a block of administrative offices, a geology classroom and museum, an engraving room, a research laboratory, an enlarged laboratory for inorganic and physical chemistry and laboratories for metallography and pyrometry, assaying and mechanical testing.

DURING June, July and August, Smith College continued its program of field studies in geology under the direction of Howard A. Meyerhoff and Robert F. Collins. The Black Hills of South Dakota was again the center of field operations. A correspondent writes that "among the several research problems which were given special attention, considerable progress was made on the stratigraphic subdivision of the Deadwood formation. With the cooperation of Christina Lochman, faunal zones have been differentiated throughout the entire formation, and the paleontological collections have been materially enlarged as a result of the season's work. A study of the contact between the Pahasapa limestone (Mississippian) and the overlying Minnelusa formation (Pennsylvanian) was also started. The pre-Minnelusa solution phenomena in the Pahasapa limestone and the lateritic features of the re-worked soil at the base of the Minnelusa suggest an epoch of tropical weathering and the development of karst topography before Pennsylvanian sedimentation began. A reconnaissance of the Tertiary deposits of southeastern Wyoming, with particular attention to the mammalian remains, concluded the summer's work."

DISCUSSION

CREST AND HERNIA IN FOWLS DUE TO A SINGLE GENE WITHOUT DOMINANCE

SOME five years ago I undertook an experiment with poultry involving the introduction of a number of genetic factors, regarded as dominants on the evidence of the crosses among domestic breeds, into a stock of wild jungle fowl, *Gallus gallus*. The experiment was designed to test a crucial point in dominance theory, for if the supposed dominants had become so through human selection during the process of domestication this fact could be demonstrated by showing that in wild stocks, which had not been subjected to this selection, dominance was absent, and the heterozygote was clearly intermediate between the two homozygous types. Until the present year, therefore, heterozygotes, each manifesting one of the group of factors to be tested, had been mated back to the wild stock.

This year, 1934, among other tests, heterozygous crested of the fifth generation were interbred and, at hatching, it was immediately seen that about a quarter of the offspring manifested cerebral hernia. The obvious inference that cerebral hernia is in itself a homozygous manifestation of the gene for crested can only be demonstrated with certainty by breeding from the chicks with hernia, if any survive. The conclusion is, however, supported by the data on hernia published by the earlier poultry geneticists, although the genic identity with crest seems to have been overlooked.

A number of crosses involving the crested varieties, Polish, Houdan and Silky, were reported by Davenport[1] in 1906. Only two of these seem, however, to have been carried as far as the second generation, and the data given are difficult to follow, owing to inconsistencies in the numbers tabulated. His conclusions are: (1) That "cerebral hernia is inherited in Mendelian fashion with plain head dominant. Nevertheless, many of the plain head hybrids have the frontal eminence abnormally high—dominance is imperfect." (2) The crest is independent of the cerebral hernia." (3) "Crest is inherited in Mendelian proportions, and is dominant over crestless head. Even when the Silky is crossed with *Gallus bankiva* its crest is dominant. In this case the new characteristic, a positive variant, dominates over the ancient one; but the crest is diminished in the first generation; dominance is imperfect."

It is difficult to understand Davenport's statement that the crest is independent of cerebral hernia. For, of the two cases (Polish × Minorca) in which a second generation was bred, and classified simultaneously for the presence of crest and hernia, there appear in the table (p. 16) for the first cross: Normal, 21; crest without hernia, 34; hernia without crest, 3; crest and hernia, 12; total, 70.

Of the crested birds recorded over a quarter show hernia, whereas of the uncrested the proportion recorded is only one eighth. Moreover, it is evident that there is a deficiency in the numbers of crested recorded, the expectation out of 70 being 52.5. This discrepancy Davenport ascribes to misclassification of embryos, giving for comparison the numbers of crested and uncrested obtained from 52 chicks hatched. Since, therefore, 18 of the birds classified in his table must have died in the shell, at a stage when the crested character may be indistinguishable, the 3 birds said to have shown hernia without crest are easily explained. Hernia is immediately recognizable in the chick; I should, therefore, have no hesitation in interpreting Davenport's record of these broods as 21 normal, 34 heterozygous, 15 homozygous mutant, thus conforming entirely to a 1 : 2 : 1 ratio. These numbers are, however, apparently affected by copying errors, for in a later table Davenport gives 16 with hernia out of 70; while in an earlier table for crest he shows only 23 out of 75, instead of 24 out of 70 lacking crest.

Hernia also appeared in F_2 from Houdan (crossed with White Leghorn). In this case 11 with hernia appeared out of 45—these totals presumably including unhatched, as well as hatched chicks. Crest was classified for only 19 individuals, of which 6 were uncrested. The 13 crested individuals evidently included all those with hernia, which survived this stage, for it is stated that "hernia is never found dissociated from the crest." The number of the crested birds showing hernia is, however, not given. Both of Davenport's F_2 generations thus accord with the view that hernia in his material was manifested where the gene for crest was homozygous.

Punnett[2] comments on Davenport's statement as follows: "Davenport states in the same paper that hernia is never found dissociated from the crest, but as he himself records 3 cases of uncrested birds with hernia, his statement would seem to require modification." The statement quoted from Davenport, however, evidently only refers to his second cross (White Leghorn × Houdan), in the summary to which it occurs, and not to the first cross (Black Minorca × Polish). It is his general conclusion (p. 65) that "the crest is independent of cerebral hernia" that is doubtfully consistent with the experimental data he reports.

In connection with Davenport's table of the cross

[1] C. B. Davenport, "Inheritance in Poultry," *Pub. Carnegie Inst. of Washington*, No. 52, 1906.

[2] "Heredity in Poultry," p. 103.

with Polish, it is interesting that if hernia is taken as diagnostic for homozygotes of the gene for crest, this gene is evidently linked with another, also showing lack of dominance, which gives when heterozygous a split comb, and when homozygous the obliterated comb of the Polish breed.

The 9 genotypes thus classifiable appear in Davenport's table with the frequencies shown in Table 1:

TABLE 1

	Normal	Crest	Hernia	Total
Single comb ...	12(9.004)	8 (7.097)	2(1.399)	22
Split comb	8(7.097)	17(20.806)	4(7.097)	29
No comb	1(1.399)	9 (7.097)	9(9.004)	19

The totals for the comb character are not altogether convincing, and suggest that some heterozygotes have been classified as having the single comb. Any such misclassification would tend to increase the apparent recombination frequency, which, as judged from the data, is between 28 per cent. and 29 per cent. The expectations in the table are for 28.27 per cent.

The earlier writers, such as Hagenbach and Darwin, took the connection between Crest and Hernia for granted. Among recent geneticists Dunn and Landauer[3] consider the point and report that all herniated fowls reared to maturity have developed a pronounced crest. They consider, however, that the characters are separable on the strength of one instance in which an uncrested fowl was believed to transmit hernia. The case would, however, be convincing only if uncrested birds showing hernia had been reared from the progeny.

In a recent letter, Dr. F. B. Hutt writes, "I have decided the same as you, that there is no difference between the genes," although in Hutt's material hernia seems not to be easily classified. Probably the largest factor in preventing, hitherto, recognition of the simple relation between these characters has been the genetic suppression of the hernia in the Silky breed used in many of the experiments. Back-crossing to the wild fowl is evidently capable after some generations of eliminating the cause of this suppression.

R. A. FISHER

UNIVERSITY OF LONDON

THE NEWFOUNDLAND SEAL FISHERY

IN SCIENCE for August 24, Dr. C. Hart Merriam called attention to an announcement by the secretary of the Society for the Preservation of the Fauna of the Empire that the Newfoundland sealing industry is steadily declining and recommending that a sanctuary be provided for the protection of the seals. Dr. Merriam very properly pointed out that these ocean-dwelling seals breed only on ice floes and that a land sanctuary would not be possible.

Having before me the official records of the catch of the Newfoundland seal fishery for over a hundred years, it does not appear that the fishery has declined to a serious extent. During the period from 1860 to 1930 the average annual catch was 196,019. Due to unfavorable weather conditions in 1931 and 1932 there was a falling off, but in 1934, 223,708 seals were taken.

Prior to the middle of the nineteenth century large numbers of sailing vessels engaged in this fishery. At one time in the fifties, there were 400, it is said. The annual catch *occasionally* exceeded half a million seals. Later, when the sailing vessels were replaced by steamers, the hunting season was officially shortened with a view to conservation.

Sealing operations are now permitted only between March 10 and April 15. Owing to the present low price of seal skins and oil only nine steamers were employed in making the large catch of 1934—223,708 seals.

This long established seal fishery is unique in that it is based on the taking of *young* seals only, the number of adults captured being negligible. Adults take to the water at once, upon the approach of the hunters, the extremely fat, nursing young being unable to leave the ice floes on which they are born.

The catch has always been made on ice floes not far from Newfoundland. Doubtless both Harp and Hood seals, the two species on which the fishery is based, bring forth their young on ice fields more remote and more difficult to penetrate by vessels. It is evident that the survival of great numbers of breeding seals has hitherto sufficed for the notably prolonged maintenance of the fishery. I have records of catches dating back to 1795. With no heavier killing than that of the past decade the fishery may last indefinitely.

We have for some time urged that the control of sea lions on the Pacific coast be brought about by commercial use of the nursing young before they are old enough to take to the water, rather than by wanton destruction of breeding sea lions that sink when shot. Young sea lions represent a resource in usable leather and oil that has hitherto been wasted, the skins of adults not being utilized.

C. H. TOWNSEND

THE NEW YORK AQUARIUM

OVERWINTERING OF APLANOBACTER STEWARTI

ATTEMPTS to solve the problems of dissemination and overwintering of *Aplanobacter stewarti* (E. F. Smith) McCul., the cause of bacterial wilt of corn, were for many years concerned chiefly with soil and seed transmission. Recently investigators have turned

[3] *Jour. Genetics*, 22: 95–101, 1930.

more and more to the study of insect transmission as the most promising field for study.

Studies recently carried on jointly by the writers have shown that the overwintered adults of the flea-beetle, *Chaetocnema pulicaria* Melsh.,[1] which commonly feed upon young corn on emerging from hibernation, harbor *Aplanobacter stewarti*. Adults of *C. pulicaria* were collected from orchard grass and alfalfa at Arlington Experiment Farm near Rosslyn, Va., during April, 1934. Four lots of these adults were sterilized externally in a solution of 4 per cent. sodium hydroxide and then rinsed in a solution of 0.1 of 1 per cent. hydrochloric acid before being macerated in sterile beef broth for plating. Large numbers of *A. stewarti* in practically pure culture were obtained from all four isolations. Healthy corn plants in the greenhouse were inoculated with transfers from these isolations, all developed typical symptoms of bacterial wilt and the organism was reisolated. These organisms appeared to be particularly virulent, as the symptoms developed in three to four days and the plants died soon afterward.

Other adult beetles from the same collection referred to above were permitted to feed for several days on healthy corn plants in the greenhouse. Typical symptoms of bacterial wilt developed in these plants and *Aplanobacter stewarti* was isolated from them in pure culture. Preliminary isolations from 175 single individuals of overwintered adults of *Chaetocnema pulicaria* collected from several different species of host plants indicated that the organism occurred in abundance in approximately 19 per cent. of these beetles.

It has been known for a considerable time that *Aplanobacter stewarti* may overwinter in infected seed to a limited extent, but there is no direct evidence of overwintering in naturally infested soil in the field. Since *A. stewarti* has been found to overwinter in a common fleabeetle under natural conditions, and since infection in healthy corn plants has resulted from the feeding injuries of these beetles, it appears probable that *Chaetocnema pulicaria*, and possibly other insects, may be largely responsible for overwintering as well as dissemination of bacterial wilt of corn.

CHARLOTTE ELLIOTT
BUREAU OF PLANT INDUSTRY

F. W. POOS
BUREAU OF ENTOMOLOGY
U. S. DEPARTMENT OF AGRICULTURE

[1] Identification verified by Mr. H. S. Barber, Division of Identification and Classification of Insects, Bureau of Entomology, U. S. Department of Agriculture.

INTERNAL PRESSURE IN LATEX SYSTEM

SOON after a sudden shower on a recent afternoon I was removing some almost fully grown fruits from a *Cryptostagia grandiflora* shrub in my garden. I pierced the bark of the fruit stalk near the base of one fruit and a stream of latex spurted from the wound with unusual force. The stream continued, I estimated, from two to three seconds and reached the foliage of a row of Arundina orchids which were about three and a half feet away from and about one foot below the source of the latex stream.

This same phenomenon is often noticed, but in a smaller degree when one pricks the bark of a tree of *Hevea brasiliensis* in the early morning or soon after a shower, when turgidity is high within the tree. The emission in such a case is, however, usually only a sudden spurt of latex and I have not heretofore witnessed such a long-continued flow.

W. N. BANGHAM
DOLOK MERANGIR
E. C. SUMATRA

SCIENTIFIC BOOKS

CRYSTAL STRUCTURE

The Crystalline State. Edited by Sir W. H. BRAGG and W. L. BRAGG. Vol. I. A General Survey, by W. L. BRAGG, xiv + 352 pages, 23 × 14.5 cm, with 186 figures and 6 appendices. Published by Macmillan and Company, 60 Fifth Ave., New York City, 1934, $5.50.

THIS is the first of a projected set of three volumes dealing with all aspects of the application of x-rays to the determination of crystal structure and with many of the physical properties of crystals which can be explained in terms of the structure thus determined. It is in some respects a revision and amplification of the "X-Rays and Crystal Structure" of the same authors, first written in 1914 and revised in 1924. The title is thus to a certain extent misleading, because certain groups of crystalline phenomena, such as those which can be treated formally and which have been so exhaustively treated in Voigt's monumental "Krystallphysik" are not included, and in fact Voigt's name is not even mentioned.

It is intended that the two remaining volumes of the series shall be technically complete expositions of the detailed topics; the articles in these volumes are to be written by a number of collaborating experts. This first volume gives a general survey of the whole field and is complete in itself. The sections in this first volume serve as introductions to the more detailed treatment in the later volumes. The endeavor is to so arrange the material that consecutive reading is not

necessary, and it is expected that after reading in the first volume the sections pertaining to the special topic of interest one can pass directly to the more detailed treatment in the later volume, or indeed stop with the first volume if the technical details are not of interest. This scheme of presentation makes necessary a certain amount of duplication, which however the authors feel is no disadvantage if thereby the work can be made to serve its intended double purpose as a "review of the subject and a work of reference."

The scope of the book can perhaps be best indicated by the chapter headings: "The Crystalline State," "Diffraction by the Crystal Lattice," "Experimental Methods of Crystal Analysis," "Examples of Crystal Analysis," "Crystal Symmetry," "The Principles of Structure Analysis," "Chemical and Physical Crystallography," "Crystal Texture," "X-Ray Optics," "Applications of X-Ray Methods to Problems of Pure and Applied Science," "The Diffraction of Electrons," "Historical."

The exposition of the various symmetry properties of the crystal and the physical significance of the various methods of classification of crystals into 7 or 14 or 32 or 65 or 230 groups is much fuller and more lucid than one usually finds and will be illuminating after some of the rather muddy expositions that are to be found in the literature. But it is the detailed exposition of examples of crystal analysis in Chapter IV that is particularly happy and exemplifies the vivid physical visualization which is in the best tradition of the English school of physics, and which all those who have heard the author will remember as one of the most charming features of his lectures. Other notable features are the chapter on "Texture," in which a brief account is given of the results of a structure analysis of substances like rubber or cotton fiber which is coming to be so important in industry, and the historical chapter, which could have been written only by one who himself has played a foremost part in the developments which he describes.

One does not get the impression from reading the book that the subject of x-rays is in danger of becoming exhausted in the immediate future, as one so often hears, but on the contrary Bragg sees in the application of x-ray analysis to a determination of the structure of proteins the opening of an immense new field in which x-rays will play a unique part in helping to solve the problems of living matter.

P. W. BRIDGMAN

THE PROGRESS OF BIOCHEMISTRY

Annual Review of Biochemistry. Edited by JAMES MURRAY LUCK. Stanford University Press, Stanford University, California, Vol. III, 558 pages, $5.00, 1934.

THE increase in the literature concerned with the medical and biological sciences has of recent years been so great as to make almost impossible detailed and comprehensive study of even a small part of the important contributions. Abstract journals, many of which are available, fail to afford the necessary critical point of view. This need for critical interpretation of the literature in the field of the biological sciences has been met in part by such publications as the older Ergebnisse der Physiologie of Asher and the more recent Physiological Reviews, Biological Reviews and Medicine. The limitations imposed by the broad fields to be covered are obvious. Three years ago, under the editorship of Professor James Murray Luck, of Stanford University, there appeared the first volume of the *Annual Review of Biochemistry,* a publication which aimed to discuss critically the recent developments of the more important phases of biochemistry. The immediate success of the venture has encouraged both the editorial committee and the contributors to enlarge the scope of the work.

The present volume, the third of the annual reviews, continues along the lines which have made the earlier volumes so valuable. To readers familiar with the preceding reviews, it is sufficient to point out that, in freedom from errors of typography and in general excellence, the present volume conforms to the high standards already set. In addition to the discussion of broad general subjects treated yearly, the editorial committee has announced the policy of the inclusion of "occasional reviews on topics of timely nature in which a lively interest has recently developed and significant advance been made." In accordance with this policy, the present volume includes a discussion of the biochemistry of malignant tissues and another on biochemistry in relation to dentistry. The forthcoming volume is expected to contain reviews on choline, the possible importance of which as a hormone has been suggested, and on the growth substances of plants, the auxins of Went and related substances. Continuation of this new policy should add greatly to the value of the reviews. Those topics "which by universal consent constitute the traditional divisions of the subject" will continue to be reviewed at annual or biennial intervals, however.

"The diversity of interest and outlook which characterizes investigation in any of the numerous fields of biochemistry" is shown by a survey of the laboratories of the workers who have contributed reviews to the present volume. Of the twenty-six articles included, ten only are from workers in the United States, seven originate from British laboratories, four from Germany, while Czechoslovakia, Japan, Sweden, Switzerland and Canada are each represented. The review is truly international. The word "worker" has

been used intentionally in referring to the authors of the individual reviews. Each is an active contributor to the literature of his own particular field; it is unusual to find contributions of a critical character by such investigators as Kay, Pauli, Hans Fischer, Bloor, Waldschmidt-Leitz, Gortner, the Coris and Collip in a single volume.

The attempt to include within the compass of 550 pages the literature of the vast field of biochemistry has resulted in the omission of the discussion of many important papers. Harris, who writes concerning vitamins, although citing more than three hundred references to recent investigations, well presents the point of view which authors of reviews of this sort must of necessity accept. "The space allotted has enabled us to deal with no more than about one quarter of the total number of papers published during the year. It deserves to be said that of the large number thus crowded out the great majority represent some definite addition to knowledge, filling in some detail or other on the big canvas. We make this point because superficial critics so often suggest that out of this immense annual output of papers only comparatively few can be of real permanent value. This criticism seems to the reviewer to overlook the essential fact that (as all past experience goes to prove) progress is made only by the cumulative and cooperative efforts of many different workers, each adding his contribution to the general flow of knowledge. Solitary isolated advances are few. And much work is nevertheless useful and essential, although it represents no fresh development of theory, and finds no place in our review. . . ."

The editors believe that "even at the expense of omitting references to many papers,—critical surveys of the literature, though less comprehensive, are of more value to users of the Review than uncritical compendia." This ideal of a critical survey has been maintained with few exceptions. Unfortunately, one of these, which is little more than a catalogue of abstracts and references, is concerned with one of the most important subjects in biochemistry.

Space does not permit discussion of the individual reviews. The surveys of the difficult fields of hormones and vitamins are of the same excellent workmanship which has characterized the previous reviews by these authors in earlier volumes. Particular reference may be made to the valuable résumé of the important subject of energy metabolism in the review of nutrition by Professor Brody, an author who has not previously contributed to this work. The criticism, which has been made frequently, that biochemistry in America is considered chiefly in its relations to the animal organism and to medicine, finds no justification in the present volume. Plant chemistry and nutrition are amply covered by the discussion of the terpenes and saponines, the nitrogenous constituents of green plants, mineral nutrition, metabolism of carbohydrates and organic acids in plants and the chemistry of bacteria.

Professor Luck and his collaborators have again rendered valuable service to biochemistry and related sciences. The review well deserves the support of all those interested in these fields.

HOWARD B. LEWIS
UNIVERSITY OF MICHIGAN

SCIENTIFIC APPARATUS AND LABORATORY METHODS

RAPID STAINING METHODS

NEGATIVE STAINING OF MICROORGANISMS

THE so-called negative staining is frequently very useful in studying bacteria, yeasts and other microorganisms. To make mounts the organisms are transferred to a small drop of dye on a slide, spread in a thin layer and allowed to dry. They will then appear as colorless objects in a stained background. The dyes commonly used for this purpose are aqueous solutions of nigrosin (1 per cent.) or Congo red (2 per cent.). After the film of Congo red has dried, the color may be changed to blue by adding a drop of 1 per cent. hydrochloric acid in 95 per cent. alcohol. For examining such preparations either immersion oil or Nujol should be placed directly on the film.

In making negative preparations the writer has found that the addition of certain other dyes to aqueous nigrosin is very advantageous. The use of such mixtures results in various colors of background and, in some cases, in light staining of the organisms. Many dyes have been tried, but the most satisfactory ones are rose bengal, Magdala red, cotton blue and acid fuchsin. A 1 per cent. aqueous solution of any one of these dyes, excepting acid fuchsin, is added to a 1 per cent. nigrosin solution in the proportion of 1 to 3. Traces of acid may be added to the nigrosin-cotton blue mixture, but should not be added to the other two mixtures (nigrosin and rose bengal or Magdala red), although the addition of a little alkali to them may be advantageous. Of course the proportions of the dyes in the mixtures may be varied as desired. In the case of acid fuchsin 30 drops of the dye solution (1 per cent.) and 4 drops of concentrated hydrochloric acid are added to 40 cubic centimeters of aqueous nigrosin.

After films of nigrosin alone, or in combination with another dye, have dried they may be fixed to the slide, so that they will not wash off readily with water by covering with a drop of 2 per cent. ferric chloride and, after a minute, washing with water.

The nigrosin-cotton blue combination is very good as a background for stained mounts (Dorner's method or modifications of it) of spores of bacteria or yeasts, vegetative, capsulated or slime-producing bacteria, small asci and spores of fungi (Gibberella, Diaporthe, Dothidella, etc.), some protozoa and other small organisms. The arrangement of the cilia of Paramoecium in such mounts can be seen well enough to count them readily.

Generally there is little difference in the results obtained with nigrosin combined with rose bengal or with Magdala red. They have been used satisfactorily for vegetative, capsulated or spore-bearing bacteria, vegetative yeasts, spores and asci of fungi, and germinating spores of smuts to show promycelia and sporidia. If one introduces the material to be examined into the dye mixture and allows the preparation to dry the cells will be colorless, or nearly so, in a stained background; but if the stain is added to a *dry* smear (bacteria, yeast, germinating smut spores) and allowed to dry the vegetative cells will stain a shade of pink or red. This makes it possible to demonstrate clearly spores of bacteria, especially with nigrosin plus Magdala red, the preparations showing colorless spores in pink cells.

Nigrosin combined with acid fuchsin is exceptionally good for demonstration of spores in bacteria and yeasts. Spores of bacteria will appear much the same as described for Magdala red; but with yeast, if the cultures are used soon after they begin to form spores, the mother cell or ascus appears colorless, while the spores stain pink. Smears of either bacteria or yeast should be allowed to dry on the slide before the dye is applied.

A Rapid Staining Method for Dividing Cells

Although there are numerous methods of staining dividing cells to show mitotic figures, most of them are rather time-consuming. The following procedure requires a minimum of time and results in excellent preparations which are exceptionally clear and transparent. The method has been used especially for cell division in root tips and in anthers of *Lilium,* following fixation with chromo-acetic or Flemming's fluid. It is easier than triple staining and well adapted for the beginner. All reagents may be kept in pipette bottles.

After removing the paraffine from sections treat them in order with absolute, 95, 70, 50 and 30 per cent. alcohols, followed by water. In doing this put 2 or 3 drops of each in succession on the sections, let each act 20 to 30 seconds and drain before adding the next one. Then stain on the slide for 3 to 5 minutes with anilin-alcohol-fuchsin.[1]

Water, distilled	30 cc
Basic fuchsin, 10 per cent. alcoholic	10 "
Anilin oil (1 part) and 95 per cent. alcohol (3 parts) mixed	5 "
Acetic acid, 4 per cent.	1 "

Mix in the order given, filter once or twice and again before using. This solution is best after standing three to six days and generally works well for three to five weeks. Refiltering may be necessary.

Wash with 3 or 4 changes of water and then dehydrate with the alcohols to 95 per cent. alcohol containing a trace of hydrochloric acid (for destaining), then with 95 per cent. and absolute alcohol. Counter stain with one tenth per cent. solutions of Orange G and light green in clove oil (mixed in proportion of 1:3), wash off with absolute alcohol, clear with xylol and mount in balsam. Anilin blue in 90 per cent. alcohol is also a very good counterstain.

This entire procedure will require about eight minutes and, after a little practise, one can stain seven or eight slides per hour. When staining jars are used for the different grades of alcohol, they soon become colored with dye. In the method outlined the alcohols, stains and xylol are discarded after being used once. However, this is not wasteful as the amount of material thrown away in making a slide is not more than two or three cubic centimeters, and one has the satisfaction of always working with clean chemicals.

Light green in clove oil gives a beautiful contrast, but is certain to fade after some time. Orange G alone may overstain quickly, but when mixed with light green it stains less deeply and one gets a greenish shade that will be visible for some months, after which the Orange G alone remains.

Very fine preparations may also be made by substituting crystal violet for basic fuchsin in the formula given above. Or one may obtain a red tinged with violet in the chromatin by staining with the crystal violet three to five minutes and, after washing with water, staining three to five minutes with the basic fuchsin.

Another variation is to use safranin instead of basic fuchsin, made according to the following formula:

Safranin, 3 per cent. in absolute alcohol	20 cc
Distilled water	20 "
Alcohol, 95 per cent. (3 parts) plus anilin oil (1 part)	5 "
Counterstain with anilin blue in 90 per cent. alcohol.	

[1] W. E. Maneval, "Some Staining Methods for Bacteria and Yeasts," *Stain Technology,* 4: 21–25, 1929.

The anilin-alcohol-safranin is also very satisfactory for staining sections of stems and leaves. The stain may be prepared as above with the addition of one cc of 4 per cent. acetic acid. After the usual procedure, stain 3 to 10 minutes, wash with water, counterstain with ½ per cent. cotton blue in 70 per cent. alcohol for a few seconds, dehydrate, clear and mount in balsam. The entire process is carried out on the slide, staining jars being unnecessary.

Another combination of dyes that is apparently as good, or nearly as good, as safranin and cotton blue for stem and leaf sections is anilin-alcohol-basic fuchsin (3 minutes) followed by Delafield's haematoxylin.

W. E. MANEVAL

UNIVERSITY OF MISSOURI

THE DETERMINATION OF CO_2 CONTENT OF AN ATMOSPHERE IN A CLOSED SYSTEM[1]

IN a previous publication[2] a colorimetric method was described for the determination of the CO_2 content of an atmosphere. This method was based on the estimation of pH in a standard $NaHCO_3$ solution in equilibrium with the CO_2 in the atmosphere. As described, the method was not applicable to closed systems; since many physiological studies make use of closed containers, two modifications have been devised which can be used in these studies.

Method 1: This is a modification of a method described by Osterhout for measuring the respiration of bacteria.[3] The atmosphere from the closed system is circulated through a 13 mm test-tube fitted with an inlet tube drawn to a 1 mm capillary tip and containing approximately 4 cc of $NaHCO_3$ solution plus indicator. The latter is prepared by mixing 1 cc of a given indicator with 20 cc of 0.001N $NaHCO_3$. The gas is circulated through the solution by means of an ordinary aspirator bulb and returned to the original container. About 20 aspirations of the bulb circulates enough gas to bring the solution to equilibrium with the atmosphere; its pH is determined by comparison with a standard Hellige color disk and the pCO_2 read from the standardization curve.[2] For cresol red or brom-thymol-blue the equation of this curve is:

$$\text{Log } pCO_2 = 7.30 - pH$$

This method is fairly accurate and more rapid than any heretofore suggested. However, if several determinations must be made at short intervals, a second method which automatically indicates the pCO_2 proves more satisfactory.

Method 2: An automatic determination of the pCO_2 in the atmosphere of a closed system can be obtained by suspending a 25 x 50 mm tube containing 2 cc of the $NaHCO_3$ plus indicator solution inside the closed system, with provision for addition and withdrawal of the solution. At any time the CO_2 content of the atmosphere can be determined from the color of the solution. For accurate work, the pH can be estimated by comparison with standard buffer solutions (2 cc in a 25 x 50 mm tube). With a little practise, however, the operator can judge the pH of the solution without the use of these standards. Although this device can be used to estimate the actual CO_2 content of the atmosphere in a closed system, it is of especial value for notifying the operator when the CO_2 has reached a given predetermined level. In the latter case, an indicator is used which exhibits a pronounced color change at a pH corresponding to the pCO_2 desired.

Tests of the methods: To test the methods, a known quantity of CO_2 was added to the atmosphere in a closed system. After 20 minutes, the time found to be necessary for the suspended solution to reach equilibrium with the atmosphere, the pCO_2 was estimated by the two methods; the buffer standards were used in the automatic method to insure greater accuracy. Both methods gave satisfactory results in tests of atmospheres whose CO_2 content ranged from 0.03 to 0.7 per cent. The estimations checked the actual quantity of CO_2 within 5 to 10 per cent., which is the limits of accuracy for the colorimetric method.

In connection with various physiological studies both methods have proved reliable in greenhouse experiments. The second method is particularly useful when CO_2 must be added periodically to a closed container. An indicator is selected which has a definite color change at a pH corresponding to the lowest level of CO_2 desired. For example, if it is required to keep the CO_2 level greater than 0.15 per cent., phenol red is an appropriate indicator, since at this concentration of CO_2 it turns from a definite yellow to a definite pink. If the CO_2 is not to be added until reduced to the concentration of air, cresol red is satisfactory. Greenhouse tests on the second method carried out over a period of six months show that the color change of the indicator corresponds to a quite definite pCO_2 in the atmosphere and that the method can be entirely relied upon to indicate when CO_2 shall be added to plants in physiological experiments. The indicator solution used should be changed at least every three days for highest accuracy.

ELIZABETH M. SMYTH

[1] Herman Frasch Foundation in Agricultural Chemistry, Paper No. 80. Contribution from the Departments of Agricultural Bacteriology and Agricultural Chemistry, University of Wisconsin.

[2] P. W. Wilson, "Colorimetric Method for Determination of CO_2 in Gas Mixtures," SCIENCE, 78: 462–463, 1933.

[3] W. J. V. Osterhout, "A Method of Studying Respiration," *Jour. Gen. Physiol.*, 1: 17–22, 1918.

SPECIAL ARTICLES

THE BIOLOGICAL SIGNIFICANCE OF THE LESIONS OF MULTIPLE SCLEROSIS

IT has long been recognized that the characteristic lesion of multiple sclerosis is the plaque, an area in which myelin is destroyed (though often not entirely absent), axis cylinders are preserved, although often damaged, and there is an overgrowth of glia of variable intensity. Plaques may be of microscopic size, in which case they almost invariably surround a small vein, extending along it like a sleeve, or they may measure several centimeters in diameter. Typical plaques occur in no other disease, although small areas of somewhat similar structure may be encountered, for example, in paresis. The lesion may therefore be considered pathognomic.

Recent observers almost unanimously agree that the lesion is a progressive one. In all cases areas may be found in which the myelin shows evidence of damage but not destruction, and perivascular infiltrations occur which are presumably transitory. More severe lesions are also found in long-standing cases, in which the axis cylinders are destroyed and glial proliferation reaches its extremest degree. In such areas there is a proliferation of capillaries. They are, therefore, mixed scars such as may be seen in the vicinity of old softenings of any origin, and histologically can not be considered in the least specific for multiple sclerosis.

Both the "early" and the typical sclerotic plaques have been produced experimentally in animals. This was first accomplished by means of minute doses of tetanus toxin,[1] but the mechanism of the pathological change remained obscure. One step in the process has recently been elucidated by the demonstration that obstruction of venules in the dog's brain with a bland oil will produce lesions of the type described.[2,3] The obstruction is produced by injecting the oil—usually triolein—between ligatures into the longitudinal sinus in such a way that it is forced against the current of blood into a cortical vein and its tributary venules. The lesions produced are usually limited to the white matter. In early stages, they consist of diffuse proliferation of fixed glial cells and mild myelin damage. The resulting picture is a close imitation of that of post-infectious "encephalitis." At the end of three months, myelin destruction has begun, and after ten months there is a dense isomorphous gliosis in the area of myelin loss, but the axis cylinders remain practically intact.

The experimentally produced lesions have such a perfect resemblance to the pathognomic lesions of multiple sclerosis that it seems scarcely possible to believe that the same histological sequence does not occur in the latter process also. It is hard to imagine any form of spontaneous obstruction in cerebral venules other than thrombosis, and as a matter of fact venous thrombi have been described in post-infectious "encephalomyelitis"[4,5] a disease which bears certain similarities to multiple sclerosis. Thrombi have been reported in cases of multiple sclerosis also, but very rarely. Their scarcity is perhaps not surprising when we consider that a thrombus in a small vessel may become so completely organized as to be unrecognizable within a week. Abnormalities in the coagulability of the blood may regularly be observed in multiple sclerosis.[6]

The sclerotic plaque may perhaps therefore be considered the mildest form of permanent damage produced by a disturbance of blood supply. Complete asphyxia of the cortex for a relatively short time leads to loss of nerve cells, but apparently if the gas exchange is disturbed to a milder degree but over a longer period, the myelin suffers most.[7,8] In areas of severe ischemia all ectodermal structures are destroyed. Loss of myelin in itself does not prevent the transmission of nervous impulses. In multiple sclerosis, a practically complete demyelination of some levels of the brain stem is compatible with life, and almost complete demyelination of the optic nerves is compatible with vision.

A consideration of the various types of lesion seen in multiple sclerosis suggests that it may be a general rule that injury to structures of ectodermal origin alone in the central nervous system leads to gliosis—that is, repair by ectodermal elements—with minimal mesodermal proliferation. To be sure, there is usually some thickening of vessels in typical sclerotic plaques, but no more than might be accounted for by organization of thrombi within, and expansion of adventitia to wall in perivascular infiltrations externally. The isomorphous character of the gliosis is doubtless to be accounted for by the persistence of axis cylinders which support the growing fibrils. Only when ischemia reaches such a degree that the capillaries become necrotic does a sort of granulation tissue make its appearance. Mallory[9] has long since called attention to the almost specific stimulation which fibrin

[1] T. J. Putnam, J. McKenna and J. Evans, *Jour. f. Psychol. u. Neurol.*, 44: 460–467, 1932.

[2] T. J. Putnam, *New Eng. Jour. Med.*, 209: 786–790, 1933.

[3] T. J. Putnam. (To appear in *Arch. Neurol. and Psychiat.*)

[4] H. Spatz, In Handbuch der Geisteskrankheiten. Bd. 11, Spez. T. VII, p. 173.

[5] P. Kreider. Personal communications concerning work to be published shortly.

[6] P. Solomon and B. Simon. Personal communications concerning work to be published shortly.

[7] A. Ferraro, *Arch. Neurol. and Psychiat.*, 29: 1364–1367, 1933.

[8] T. J. Putnam, *loc. cit.*

[9] F. B. Mallory, "Pathologic Histology," Saunders, Philadelphia, 1914.

furnishes to the growth of connective tissue—a stimulation also probably partly to be explained on mechanical grounds.

The question naturally arises, granting the abnormal coagulability of the blood, why thrombi should occur in cerebral venules rather than elsewhere. It is well recognized that venous blood coagulates more readily than arterial, perhaps because of its higher hydrogen-ion concentration, and the oxygen consumption of the brain exceeds that of other organs.[10] Further, the cerebral venules are unusually small, variable in caliber and tortuous[11]—structural factors which impede the flow of blood and so doubtless favor clotting. But perhaps it should be admitted that we have no data in regard to the presence of thrombi in venules in other parts of the body. It is quite possible that they do occur, disappear and, except in the nervous system, leave no trace behind.

The problems of the precise nature of the change in coagulability of the blood, of its cause, and whether it may be influenced by any therapeutic procedure, are still under investigation.

TRACY J. PUTNAM

NEUROLOGICAL UNIT,
BOSTON CITY HOSPITAL

THE MUCOID PHASE OF STREPTOCOCCUS HEMOLYTICUS

IN a recent communication[1] evidence was presented to show that *Streptococcus hemolyticus* possesses three chief variant phases: (1) M (mucoid); (2) S (smooth); and (3) R (rough). Further evidence was presented to show that these three chief variant phases of *Streptococcus hemolyticus* correspond closely with the three chief variant phases of a wide variety of other bacteria. Three similar variant forms have also been identified for pneumococcus.[2] In the case of the latter bacterial species, however, there exists an unfortunate inconsistency in the terms employed to describe those phases which correspond with the chief phases of other bacteria.

The nature and the significance of the mucoid phase of *Streptococcus hemolyticus* have recently been investigated in this laboratory. It has been shown that the use of Neopeptone rabbit's blood agar plates, to which 0.2 per cent. dextrose has been added, facilitates the development of mucoid colonies. Three hundred and sixty-three strains of *Streptococcus hemolyticus* have been examined on this medium. The strains have been obtained from a wide variety of sources and include 118 freshly isolated cultures. The freshly isolated strains have been grown on Neopeptone media exclusively. The stock strains had been subcultured in a variety of media prior to the present study; they were then subcultured three times on Neopeptone blood-agar plates. The lack of uniformity in the cultural methods previously employed to grow the stock strains may therefore have appreciably affected the nature and appearance of the resulting growth. Under the conditions of the present study, however, the cultures exhibited a considerable degree of stability.

The source and nature of the cultures examined were as follows:

	Mucoid	Smooth
(1) Stock strains	108	137
(2) Freshly isolated strains	64	54
Total	172	191

Particular significance is attached to the origin of the mucoid and smooth variants, especially in the case of freshly isolated cultures. It can be definitely stated that there is a close parallelism between the type of infection and the variant form associated with that infection. Thus, with possibly one exception, all acute and fulminating infections have yielded mucoid organisms, while the smooth variant has almost invariably been associated with milder or more chronic forms of disease. Furthermore, there is suggestive evidence that, as the acuteness of the infectious process subsides, the organisms frequently change from the mucoid to the smooth phase. On the other hand, mucoid organisms have occasionally been encountered in the throats of individuals long after the acute stage of the infection has subsided.

Two main varieties of smooth organisms have also been identified; one of these produces convex, glossy colonies of moderate size; the other forms larger, flatter, faintly granular colonies with a "porridgy" consistency. The former variety is frequently associated with sub-acute or subsiding infections and the latter variety is commonly found in more chronic conditions and in apparently normal throats. The evidence suggests that these two forms constitute different phases of the same organism and that the larger colony represents the initial stage of a transformation to the true R form.

Virulence: Cultures exhibiting a high degree of virulence for white mice are usually, if not always, in the mucoid phase. On the other hand, all mucoid cultures are not necessarily virulent. Smooth cultures are definitely less virulent: in moderate dilutions they may cause the death of animals, but cultures from the peritoneum and heart's blood of such animals usually yield mucoid organisms. In these cases it seems reasonable to assume that there has been a change from the smooth to the mucoid phase within the animal body.

[10] W. Lennox, *Arch. Neurol. and Psychiat.*, 6: 719–724, 1931.

[11] R. Pfeifer. Berlin: Julius Springer, 1930, pp. 220.

[1] M. H. Dawson, *Proc. Soc. Exper. Biol. and Med.*, 1934, 31, 590.

[2] M. H. Dawson, *Proc. Soc. Exper. Biol. and Med.*, 1933, 30, 806; *Jour. Path. and Bact.* (in press).

Capsule formation: Organisms in the mucoid phase form definite capsules. Such capsules can be readily demonstrated by Muir's stain in peritoneal exudates and with somewhat greater difficulty on organisms grown on solid media.

Lack of type-specificity: Preliminary agglutination studies have failed to yield any evidence of type-specificity for organisms in the mucoid phase.

Soluble substance: Filtered saline suspensions of organisms in the mucoid phase give a definite precipitate with serum prepared against organisms in that phase. This precipitable substance appears to be different from any previously isolated constituent of *Streptococcus hemolyticus.* The indications are that this substance is common to the mucoid phase of the several strains examined. The chemical nature of this soluble substance is being further investigated.

SUMMARY

(1) The occurrence and distribution of the mucoid phase of *Streptococcus hemolyticus* is indicated.

(2) Severe and acute infections usually yield organisms in the mucoid phase: mild and chronic infections usually yield smooth organisms.

(3) Organisms which are highly virulent for mice produce mucoid colonies; but all mucoid cultures are not necessarily virulent.

(4) Organisms in the mucoid phase produce a soluble precipitable substance which is common to the several strains examined.

MARTIN H. DAWSON
MIRIAM OLMSTEAD
COLLEGE OF PHYSICIANS AND SURGEONS
COLUMBIA UNIVERSITY AND THE
PRESBYTERIAN HOSPITAL

AN EXPERIMENTAL ANALYSIS OF THE CAUSE OF POPULATION FLUCTUATIONS

IT has previously been shown that populations of the confused flour beetle (*Tribolium confusum* Duval) which are confined in beakers of whole wheat flour come to a "steady state" or "quasi-equilibrium," especially with respect to the adult populations.[1, 2, 3] Under such conditions the egg populations show certain interesting and periodic fluctuations. It has been the object of the experiments under consideration to determine the causes of these fluctuations.

When an experiment is initiated with a number of adult beetles that is well below the "saturation point," the number of eggs present in the environment increases until it approaches the "potential number"[4] and then drops off to rise again when the daughters of the original population begin to lay eggs. Theoretically, the number of eggs present in the environment should remain at the "potential number" unless the females cease to lay their daily quota of eggs or some factor within the environment causes the eggs to disappear. The basis for this statement is the fact that the daily quota of eggs will accumulate each day during the period between oviposition and hatching. On the day that the first daily quota of eggs hatches an equal number of eggs will be laid and the number of eggs present in the environment should remain constant. If there is a change in the number of eggs present it must mean either that the oviposition rate has not remained constant or that some factor in the environment has interfered with the eggs. Good[5] and others have shown that under ordinary conditions the females continue to lay eggs for over a year; hence it seems that some factor in the environment may be involved.

It has been shown repeatedly that the number of eggs rises to the potential number and then falls to a low level as the number of larvae in the environment increases.[6] Park[7] and Maclagan[8] have called attention to the fact that the net number of eggs present in such environments, expressed as eggs per female per day, decreases as the population increases. The attention of these authors has been devoted primarily to the matter of adult populations and they have concluded that the reduction in the number of eggs and larvae has been due to a decrease in the rate of oviposition. It is difficult to prove that oviposition is the variable factor, because the coefficient of variability of the rate of oviposition of individual females has been determined to be as high as 62 per cent.[9]

In the experiments now being reported upon, "oviposition" was maintained constant in order to mea-

[1] Royal N. Chapman, "Quantitative Analysis of Environmental Factors," *Ecology*, 9: 111–122, 1928.

[2] F. G. Holdaway, "An Experimental Study of the Growth of Populations of the Flour Beetle *Tribolium confusum* Duval, as Affected by Atmospheric Moisture," *Ecol. Monographs*, 2: 261–304, 1932.

[3] John Stanley, "A Mathematical Theory of the Growth of Populations of the Flour Beetle, *Tribolium confusum* Duval," *Canadian Jour. Res.*, 6: 632–671 and 7: 426–550, 1932.

[4] The "potential number" is the product of the average number of eggs laid per female per day, the number of days required for the eggs to hatch and the number of females present.

[5] Newell E. Good, "Biology of the Flour Beetles, *Tribolium confusum* Duv. and *T. ferrugineum* Fab.," *Jour. Agr. Res.*, 46: 327–334, 1933.

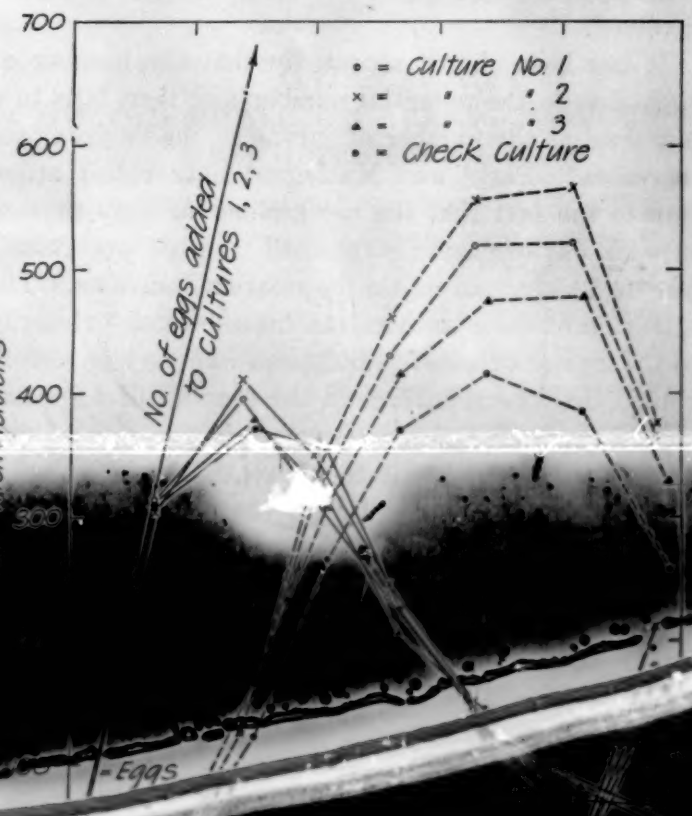
[6] Royal N. Chapman, "Animal Ecology," McGraw-Hill Book Co., pp. 212–214, 1931.

[7] Thomas Park, "Studies in Population Physiology: The Relation of Numbers to Initial Population Growth in the Flour Beetle, *Tribolium confusum* Duval," *Ecology*, 13: 172–181, 1932.

[8] D. S. Maclagan, "The Effect of Population Density upon Rate of Reproduction with Special Reference to Insects," *Proc. Roy. Soc.*, B. 111: 437–454, 1932.

[9] Royal N. Chapman and Lillian Baird, "The Biotic Constants of *Tribolium confusum* Duv.," *Jour. Exp. Zool.* In press.

sure the factors in the environment which act in reducing the number of eggs present at various times during the period when the population is rising to the quasi-equilibrium. In order to do this four beakers were set up, each containing 32 grams of whole wheat flour which had been reduced to a fineness which would permit it to pass through a number four standard silk bolting cloth. In one of these beakers eight pairs of flour beetles were introduced as a check population. Sixteen adult male beetles were placed in each of the other three beakers to be compared with the check population; and each day eggs were added at the rate that they would have been laid at the prevailing temperature, if half of the number of adults had been females. Thus the number of eggs added became a known quantity. Inasmuch as Park[10] has shown that males eat eggs at the same rate as females, the egg eating in these populations should be comparable with the check population. If nothing in the environment interfered with the eggs they should have increased in number until they reached the "potential number" and remained constant.



The accompanying graph (Fig. 1) shows that the number did not remain constant and that all four egg populations followed approximately the same course. On the 33rd and 34th days after 1,455 eggs had been added to the three synthetic populations the numbers of eggs were 142, 150 and 141. The check environment with eight females contained 135 eggs. The drop in the number of eggs present is coincident with the rise in the number of larvae. Since the larvae are known to eat eggs[4] and seem to represent the only change in the environment, it seems probable that they were the major factor concerned with the decrease in the number of eggs.

Park[11] and Maclagan[12] compared the number of eggs and larvae "per female per day" based upon counts of cultures on the 11th and 25th days and concluded that the smaller numbers at higher population densities demonstrated that population density decreased the oviposition rates. In the "synthetic populations" in the present experiment there were only 3.2, 3.4 and 2.87 eggs and larvae "per female per day" on the 26th day, although 4.6 had actually been added.

It is to be noted, however, that the numbers of larvae appearing in the three "synthetic populations" are greater than in the normal population which served as the check. The difference between the numbers of larvae in the three "synthetic populations" is comparable to that between the lowest "synthetic population" and the check. Comparison with other data[13] shows that there is a considerable fluctuation in the number of larvae present at the peak of the larval curves and as yet there seems to be no adequate explanation other than to ascribe the differences to experimental errors.

From the present experiments it seems evident that population systems of [illegible] beetles produce a resistance to their own [illegible] potential rate of increase, in spite of a constant [illegible] of oviposition, and that this resistance is responsible for the decrease in the [illegible] population that occurs in the early history of [illegible] of flour beetles.